NESSiE: an experimental search of sterile neutrinos with the CERN-SPS beam‡

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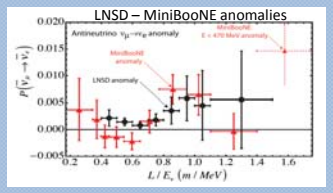
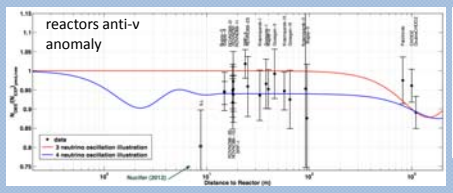
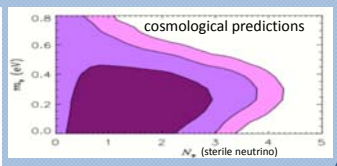
Reactor and LNSD-MiniBoone anomalies, and Cosmological hints are indications of effective neutrino number Neff > 3. Using ν_μ and $\bar{\nu}_\mu$, which includes ν_e contribution, the oscillatory distance dependence of the disappearance/appearance rates will settle the origin of the anomalies. The best measure is obtained with the combination with LAr – TPC (ICARUS) either for a positive or negative result ‡.

Experimental motivations







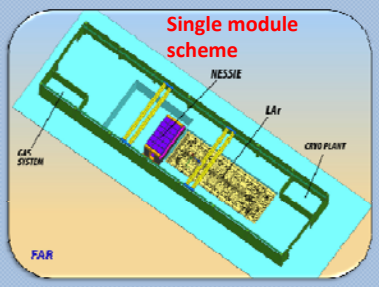
‡ arXiv:1203.3432v1 [hep-ex]

Experimental site

New SPS beam layout: - 100 GeV primary p fast extracted from SPS - on axis beam option

- **Neutrino pulse duration 10.5 μs - decay pipe = 100 m - Ø = 3 m - beam σ = 0.53 mm**
- **beam dump 15 m of Fe with graphite core, followe by μ stations - beam angle ~ 5 mrad**
- **neutrino <E> ~ 2 GeV - requirement: 4.5x10^{19} pot/year**

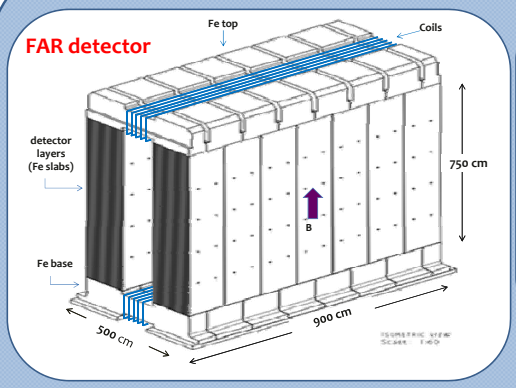
Instalation at CERN



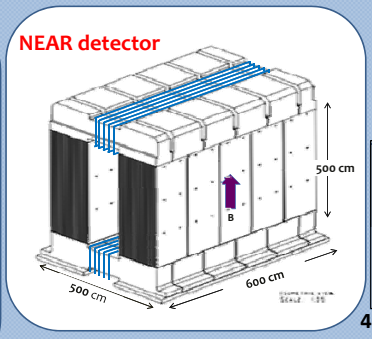
NESSiE is a modular detector formed by two (NEAR and FAR) Fe + Air spectrometers Placed downstream L-Ar* detectors*.

** arXiv:1111.2242v1 [hep-ex]*

Iron Magnets

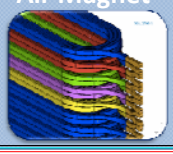


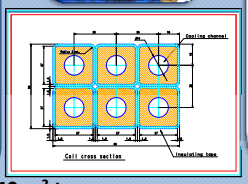
two arm magnet, B = 1.5 T
M = 1515 t (294 slabs)
1800 m^2 of RPC, 20000 digital channels



two arm magnet, B = 1.5 T
M = 840 t (210 slabs)
700 m^2 of RPC
12000 digital channels

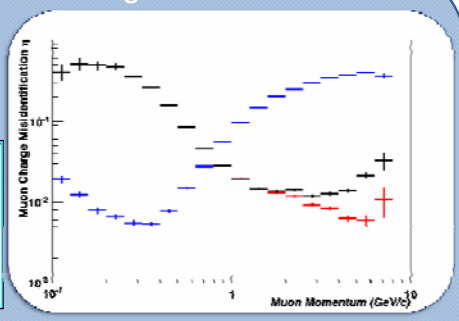
Air Magnet





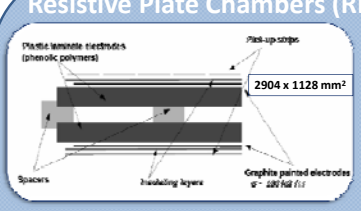
40 m^2 transverse area
80 coils (pancake array)
water cooling Ø = 2260 l/min
M = 4600 kg, B = 0.25 T
magnetic gap on air 0.3 m
FAR: 10500 m; NEAR: 6000 m

Magnets Performances



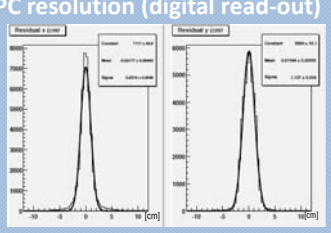
Blue markers: magnetic field on air, red (black) markers: magnetic field in iron with two (one) arms. Selection and reconstruction efficiency are included.

Resistive Plate Chambers (RPC)

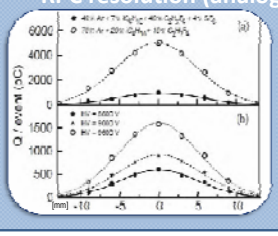


Fe magnets: V = 5.8 kV (I < 100 nA/m^2)
resolution position ~ 1 cm, time ~ ns
gas mixture Ar / $C_2H_2F_4$ / I-C_4H_{10} / SF_6
digital read-out
NEAR: exposed surface ~ 20 m^2
240 internal chambers
40 layers (2 columns x 3 rows)
FAR: exposed surface ~ 50 m^2
600 internal chambers
40 layers (3 columns x 5 rows)

RPC resolution (digital read-out)



RPC resolution (analog read-out)



Air magnets:
The streamer charge profile across the strip estimates the particle position across the RPC with ~ 1-2 mm resolution

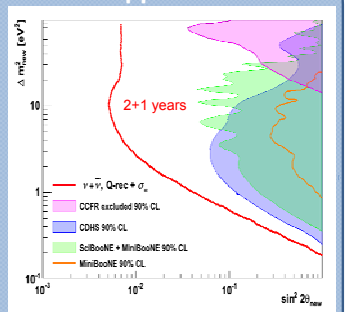
Physic goals

Expected number of events

	NEAR $\bar{\nu}_\mu$	NEAR ν_μ	FAR $\bar{\nu}_\mu$	FAR ν_μ
ν_μ LAr+NESSiE	230 K	1200 K	21 K	110 K
ν_μ NESSiE	1100 K	3600 K	94 K	280 K
$\bar{\nu}_\mu$ LAr+NESSiE	370 K	56 K	33 K	6.9 K
$\bar{\nu}_\mu$ NESSiE	1100 K	300 K	89 K	22 K
Diasappear. example	1800	4700	1700	5000

Event rates for the NEAR and FAR detectors given for 4.5 10^{19} pot (30 kW beam power, 1 years) for E_ν < 8 GeV. The oscillated signals are clustered below 3 GeV of visible energy. Values of Δm^2 ~ 2 eV^2 were considered.

Sensitivity to ν_μ disappearance



90% C.L. sensitivity for 2 years ν_μ + 1 year $\bar{\nu}_\mu$. CC events fully reconstructed in NESSiE+ICARUS